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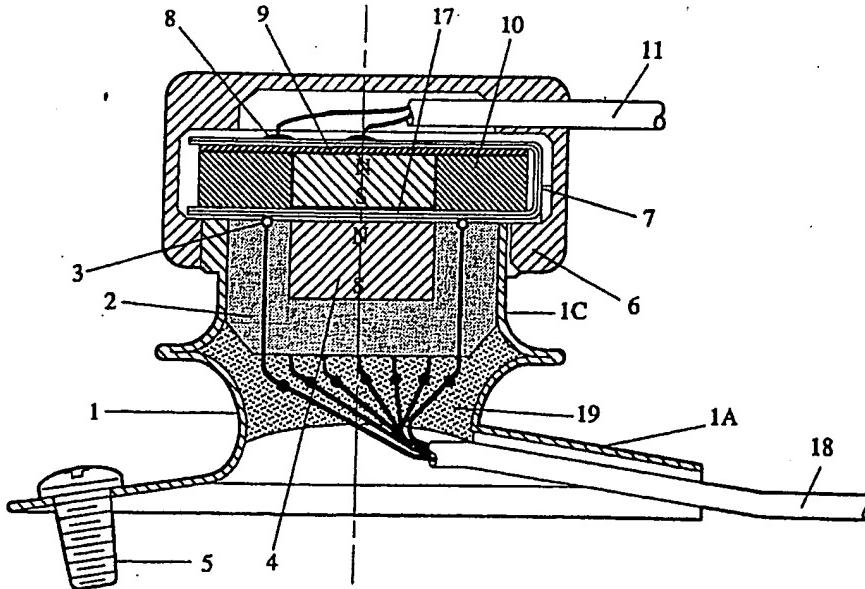
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## (54) Title: PERCUTANEOUS CONNECTOR



## (57) Abstract

A connector set for percutaneous connection of an implanted device, such as an intracochlear implant, to an external system is disclosed. The connector set preferably has a base portion (30) adapted to be affixed to bone and including a male connector, and a female connector (31) affixed externally and retained in contact magnetically. A bias arrangement (9, 10) operates between the connector components (30, 31) so that while contact is normally firm, accidental disconnection carries a reduced risk of injury to a user.

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## 1

### PERCUTANEOUS CONNECTOR

#### **Technical Field**

The present invention relates to connector systems for electrically connecting implanted devices to external devices.

#### **5 Background Art**

There is a need in many applications where an electrically controlled device is implanted into a living body for a connection to provide power for the device, and/or to form a link for sending information and commands to and from the device. Both transdermal and percutaneous devices have been used. The present invention is 10 concerned with percutaneous devices. Such devices involve a surgically implanted component, and an external component.

Prior art implants, such as that described in U.S. patent 4,025,964 to Lester J. Owens, comprise a base with a cylindrical portion terminating in a rim. The base is made from a series of holes. Inside the rim is a female portion in which sits a 15 corresponding mated plug. Two electrical connections mate with connections on the male plug. The disadvantages of prior art such as this include the presence of holes which provide locations and sites for the accumulation of infection and bodily fluids, and the necessity to have electrical conductors depending from the base in substantially perpendicular fashion due to the design. Such devices are only able to provide at most two 20 to three electrical connectors. No means is provided to secure the base to a bone structure, and further the expectation is that skin will grow around the cylindrical portion up to beneath the lower surfaces of the rim.

The mating plug is such that the magnetic material makes contact with magnet thereby ensuring contact between the connectors in plug and connectors in the socket. In 25 making contact the metal or metallic material forms a very strong bond with the magnet and whilst the inclined surfaces facilitate the dislodgment of the plug from the socket, it takes a relatively large force to do so.

It is an object of the present invention to ameliorate at least one of the disadvantages of the prior art.

#### **30 Disclosure of Invention**

According to one aspect the present invention comprises a percutaneous connector comprising a base part adapted to be attached to a bone and a male connector extending therefrom, said male connector including a first magnetic means and a contact set protruding above said first magnetic means,

and an external part comprising a female connector adapted to mate with said male connector, said female connector comprising a second contact set arranged to engage corresponding portions of said first contact set, and a second magnetic means to be attracted by said first magnetic means. Preferably said second magnetic means compresses a bias means located between said second magnetic means and said second contactor, thereby maintaining constant pressure between said first and second contactors when said male and female connectors are joined.

#### Brief Description of Drawings

An embodiment of the present invention will now be described by way of example only with reference to the accompanying drawings in which:-

Figure 1 is a perspective view in part section of a female connector for use with the present invention;

Figure 2 is a perspective view in part section of a male connector for use with the apparatus of Figure 1; and

Figure 3 is a cross-sectional view of the apparatus of Figures 1 and 2 when joined together.

#### Detailed Description of Invention

The present invention will be described with reference to a particular embodiment which is adapted for use in connecting a cochlear implant to an external device. It should be understood, however, that the invention is equally applicable to other applications with suitable modifications.

Illustrated in Figure 2 is the implanted part 30 of the percutaneous connection device according to a preferred embodiment of the present invention, which comprises a base 1 having lower base 1A and rim 1B. Lower base 1A is the main part of the base 1 which rests against a bone or other structure. Depending from the rim 1B is the male connector 1C which is made up of a centrally located ceramic disk 2 through which is carried platinum feed throughs 3A which terminate on the surface of the ceramic disk 2 as a substantially hemispherical contacts 3, such that the highest point of the connector 30 is in fact the contactors 3. Located centrally of the ceramic disk 2 is a disk type magnet 4 which is affixed thereto. The contactors 3 pass through the ceramic disk 2 in the form of single strands of wire which ultimately become conductors which are linked to the implanted device, for instance, a cochlear implant.

The base 1A is secured to a bone structure by means of screw 5 and the base 1A and screw 5 are of constructed of a biocompatible material, preferably titanium.

It will be understood that after surgical implantation, skin is intended to regrow around the base of the implanted part 30, in particular into recess 1D. Protruding rim 1B will preferably in a successful surgical result overlie and thereby protect the regrown area and the relatively delicate implant - skin junction. The use of 5 titanium or biologically similar materials is helpful as skin will typically regrow closely around such materials.

Around the top of the male connector 1C is a rim 14 having a notch 15 for locating the female connector of Figure 1. The cavity underneath the base 1A is preferably filled with a biocompatible insulating material such as adhesive silicone 10 rubber in order to protect the implant from any body fluids which may enter therein.

Illustrated in Figure 1 is an external female connector 31 which attaches to the male connectors 1C of Figure 2. The female connector preferably comprises a flexible printed circuit board 7 having contactors etched thereon which are electrically connected to the conductor 11. It will be appreciated that the conductor may be of any 15 suitable type and contain as many individual connections as are required. It can be seen from Figure 3 that PC board 7 is bent around to enable connection with conductor 11.

Sandwiched between the PC board 7 is a magnet 8, which is encapsulated by an annular elastic disk 10. Overlying the magnet 8 and disk 10 is a metal plate 9 being the full width of the elastic disk 10. This elastic disk 10 acts as a spongy bias resilient 20 mass. All of these components are encapsulated within plug body 6. At one location corresponding to the correct alignment of contactors 3 and contactors 7 is an alignment means 16 is provided for insertion in slot 15 on the male connector 1C.

Illustrated in Figure 3 are the apparatus of Figures 1 and 2 in conjoined relationship. In operation the magnet 4 attracts the magnet 8 however direct contact is 25 not made between them as is evidenced by gap 17. Whilst the gap 17 is maintained the magnets 4 and 8 are kept in close proximity to each other thereby maximising the magnetic field and force, without the magnets making contact.

The magnets 4 and 8 are preferably permanent rare earth magnets. The magnets 4 and 8 can never actually make contact due to the presence of PC Board 7 and 30 the contactors 3 being above the surface of the magnet 4. As the metal plate 9 is permanently and mechanically attached to magnet 8, magnet 4 attracts both magnet 8 and plate 9 thereby compressing silastic annular disk or ring 10 which in turn forces the lower end of PC board 7 into contact with the contactors 3 which protrude above the level of ceramic disk 2. This arrangement ensures that no contact is made between the magnet

4 and magnet 8 thus the force between them is reduced from the maximum possible, but is still sufficient to hold the two connectors together.

This arrangement allows the male and female components 30, 31 to separate relatively easily when a force is applied to the cable of connectors 11. This arrangement 5 reduces the likelihood of forced removal of the implanted component 30 during accidental contact. The base 1A has provision for radial entry of the conductors 18 and the components of the male connector are protected by means of silicon plug 19.

It will be appreciated that any suitable surgical technique may be used to install the implanted component, as would be well understood by those skilled in the art.

10 The foregoing describes one embodiment of the present invention and modifications by those skilled in the art can be made thereto without departing from the scope of the present invention.

## CLAIMS:

1. A percutaneous connector set comprising a base part and an external part, said base part being adapted to be attached to a bone and including a male connector extending therefrom, said male connector including a first magnetic means, said external part comprising a female connector adapted to mate with said male connector, said female connector including a second magnetic means and a bias means, the arrangement being such that upon said male and female connectors being operatively conjoined, the bias means is compressed so as to reduce the force required to separate the first and second magnetic means.
2. A percutaneous connector set comprising a base part and an external part, said base part being adapted to be attached to a bone and including a male connector extending therefrom, said male connector including a first magnetic means and a first contact set protruding above said first magnetic means, said external part comprising a female connector adapted to mate with said male connector, said female connector including a second contact set arranged to engage corresponding portions of said first contact set, and a second magnetic means to be attracted by said first magnetic means.
3. A percutaneous connector set as claimed in claim 1 wherein said male connector further comprises a first contact set protruding above said first magnetic means, and said female connector further comprises a second contact set arranged to operatively engage corresponding portions of said first contact set.
4. A percutaneous connector as claimed in claim 1 or claim 2, wherein said base part includes a rim of larger perimeter or circumference than said male connector, and a recess under the rim, so as to facilitate tissue regrowth around said base part.
5. A percutaneous connector as claimed in any one of the preceding claims wherein said base provides for radial entry of electrical conductors associated with said first contact set.

6. A percutaneous connector set as hereinbefore described with reference to figure 3.

7. An implantable device including a percutaneous connector set according to any one of the preceding claims.

8. A percutaneous connector comprising  
a) a pair of mating connector elements;  
b) a first magnetic material carried within one of the mating connector elements;  
c) a second magnetic material carried within the other of said mating connector elements;  
d) one of said elements being a male element including protruding electrically conductive contactors positioned around said magnet and terminating above said magnet, said contactors being connected conductors implanted beneath the patients skin;  
e) the other end of said elements being a female element including electrically conductive contactors which engage with the contactors of said male element, when said male and female elements are joined, said contactors in said female element being connected to electrical conductors external to said patients skin; and  
f) whereby when said male and female elements are joined they are held in engagement by said first and second magnetic means.

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Fig 1.

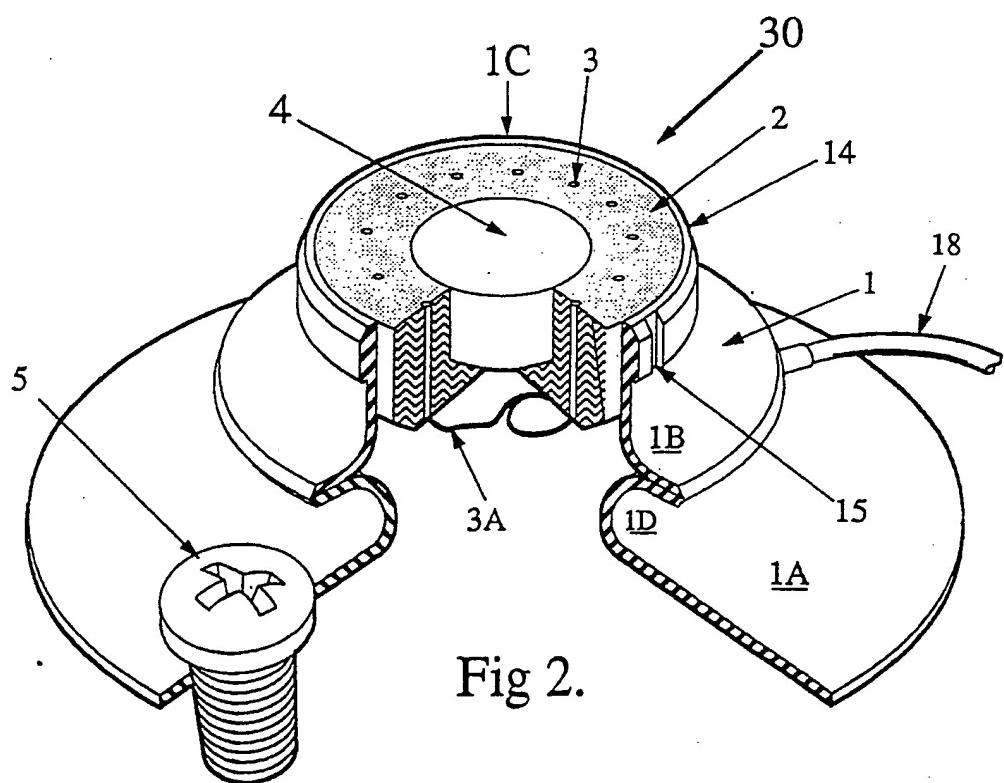
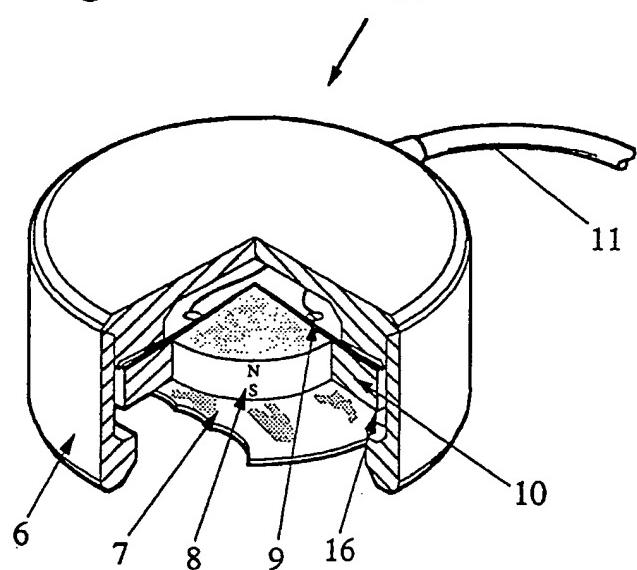
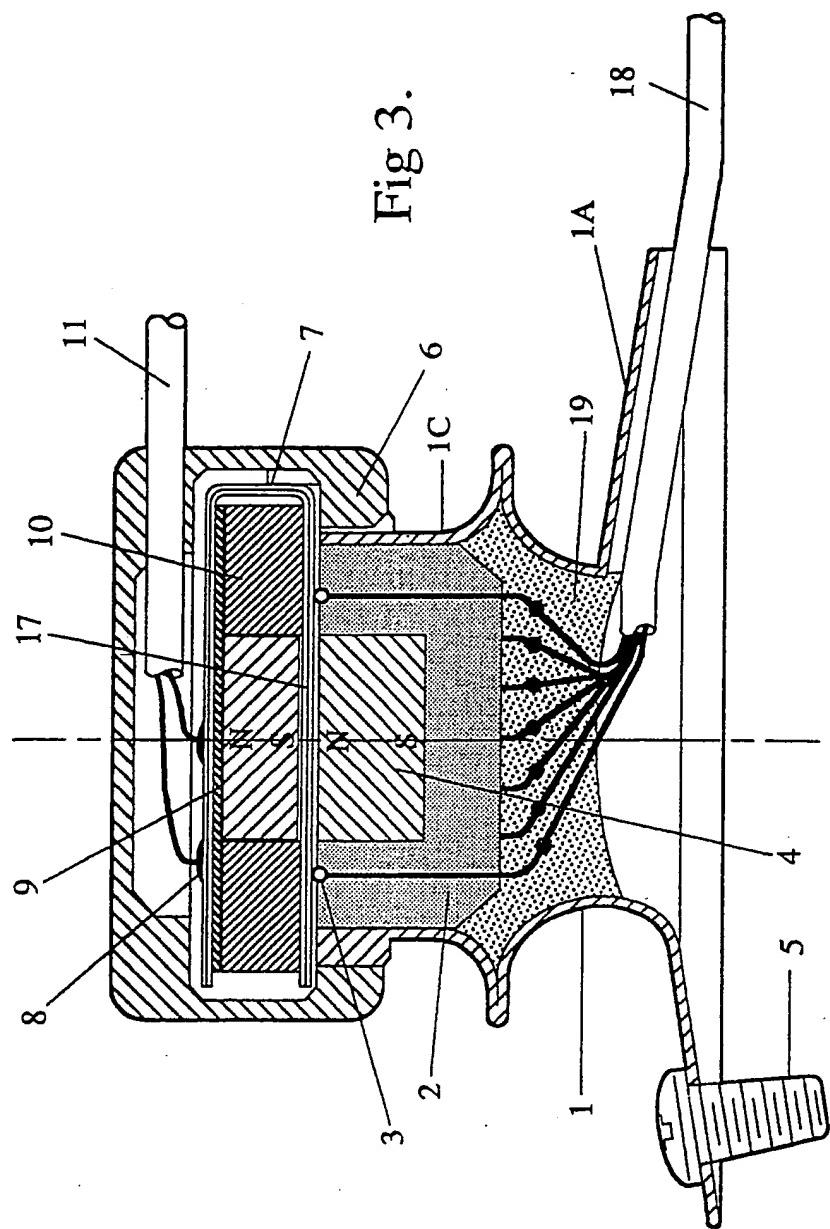


Fig 2.

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Fig 3.



## INTERNATIONAL SEARCH REPORT

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)<sup>6</sup>

According to International Patent classification (IPC) or to both National Classification and IPC  
Int. Cl.® H01R 13/639, A61F 11/04

## II. FIELDS SEARCHED

Minimum Documentation Searched<sup>7</sup>

Classification System	Classification Symbols
IPC	A61F 11/04, A61N 1/02, 1/372, 1/375, 1/378 H01R 13/62, 13/629, 13/633, 13/635, 13/639

Documentation Searched other than Minimum Documentation  
to the Extent that such Documents are Included in the Fields Searched<sup>8</sup>

AU : IPC as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup>

Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate of the relevant passages <sup>12</sup>	Relevant to Claim No <sup>13</sup>
X Y	US.A, 4025964 (OWENS) 31 May 1977 (31.05.77) See Figure and columns 2-4	2, 4, 5, 7, 8 1, 3, 6
Y	US.A, 3808577 (MATHAUSER) 30 April 1974 (30.04.74) See Figures 2, 4 and column 3 line 11 to column 4 line 38	1, 3, 6
Y	US.A, 3521216 (TOLEGIAN) 21 July 1970 (21.07.90) See Figures 2, 3 and column 3 line 44 to column 4 line 30	1, 3, 6

• Special categories of cited documents : <sup>10</sup>	"T"	Later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" Document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)		
"O" document referring to an oral disclosure, use, exhibition or other means		
"P" document published prior to the international filing date but later than the priority date claimed	"&"	document member of the same patent family

## IV. CERTIFICATION

Date of the Actual Completion of the International Search 30 July 1992 (30.07.92)	Date of Mailing of this International Search Report 6 Aug 1992 (06.08.92)
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International Searching Authority	Signature of Authorized Officer
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M S Mayne
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## FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

V.  OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE <sup>1</sup>

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claim numbers ..., because they relate to subject matter not required to be searched by this Authority, namely:
  
  
  
2.  Claim numbers ..., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
  
  
3.  Claim numbers ..., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4a

VI.  OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING <sup>2</sup>

This International Searching Authority found multiple inventions in this international application as follows:

Claims 2, 4, 5, 7, 8 do not materially differ from the Applicants submitted prior art.

Claims 1, 3 and 6 differ by a bias means.

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:
  
  
  
3.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:
  
  
  
4.  As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

## Remark on Protest

- The additional search fees were accompanied by applicant's protest.
- No protest accompanied the payment of additional search fees.